Building Composer

Criteria-Based Facility Design

Building Composer is a suite of tools for use by planners, designers, and engineers during the initial phases of facility planning and design. While originally developed to support the design of government facilities, *Building Composer* is based on the general concepts of: (1) providing a method to effectively and creatively create and use criteria libraries, (2) providing support for architectural programming and project specific criteria specification during interactive design charrettes or at the designer's desktop, and (3) supporting the creative and analytical aspects of architectural conceptual design involving the creation of one or many solutions from the specified criteria in an intuitive design environment.

While not enforcing any particular design process, *Building Composer* is designed to be able to support the iterative process shown in Figure 1,
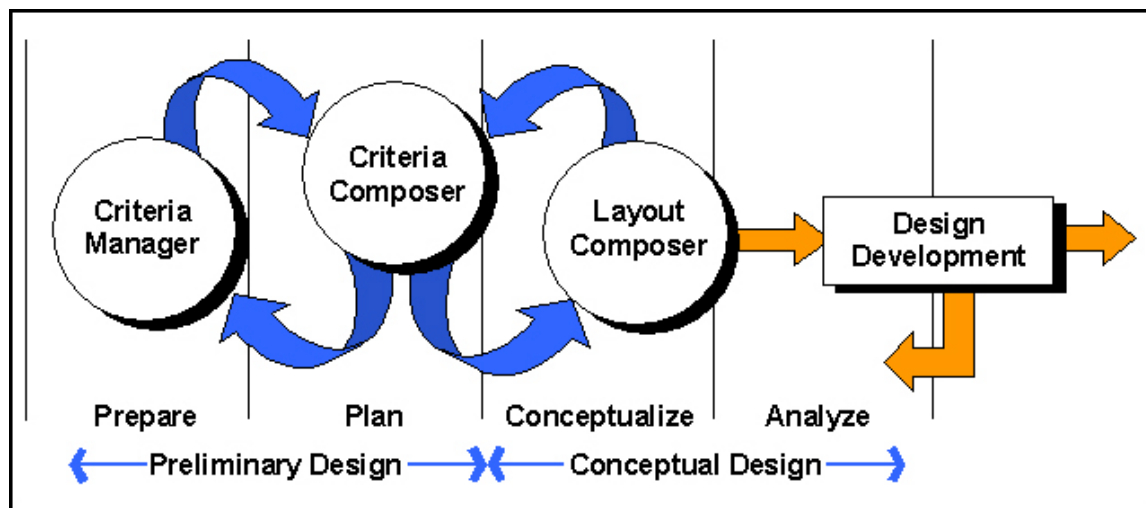

Figure 1. Process Flow of *Building Composer* Tools.

The most important concept of *Building Composer* is that **customer-specific and computable criteria are associated with the facility model**. While many volumes of government design criteria exist in the form of design guides, regulations, technical manuals, and web pages, few, if any, of these are expressed in a computable format. In addition, current design systems do not provide a way to directly interact with these criteria, nor do they provide an efficient way to extend the functionality of an application to directly support criteria usage.

In *Building Composer*, criteria can be associated to different project elements based on the appropriate level of detail, from the **project** to the **site**, the **building**, **story**, **function**, down to the individual **space**. For example, *Building Composer* allows one to specify that a target schedule and cost be associated to a project, that masonry exterior walls and a steel structure be used on a building, that 32-Watt T-8 florescent lights be used in corridors and 50 footcandles be maintained in the offices, and that a particular room will have VCT flooring. These criteria are then used to inspire and compare against during downstream design decisions. *Building Composer*'s ability to maintain a linkage between criteria and project elements (site, building, story, etc.) provides many benefits:

- It helps ensure that critical criteria are followed, and that desired characteristics are recorded and addressed.

- It helps organize criteria and makes it available at its point of use. It helps in defining criteria and can help in recording its rationale.

- It simplifies creation, maintenance, and distribution of new criteria. For example, as requirements that better implement sustainable design principles are developed, these are added to an organization's standard library for use in subsequent projects. These libraries are typically organized around facility type, but are not required to be.

- It helps support conceptual and detailed design & analysis (cost, structural, HVAC, energy, electrical, O&M, etc.) either directly or through standards, such as the [International Alliance for Interoperability's Industry Foundation Classes (IAI-IFC)](#) and [Building Lifecycle Interoperable Software (BLIS)](#).

Large owners, in particular, reap benefits from this approach as it helps ensure the initial design satisfies their corporate criteria, shortening the review process and avoiding "design by review." All of these benefits result in cost and time savings by reducing user changes late in the design process or during construction. Design quality is also enhanced, as many alternatives can be explored rapidly.

Tools

The primary tools in the *Building Composer* application suite include:

- **Criteria Manager**, a web-based application that helps in the development of corporate and building specific criteria libraries
- **Criteria Composer**, which helps users create an architectural program and to set values for project specific criteria

- **Layout Composer**, provides an environment for the user to create 3D conceptual facility designs
- **Wizards** that provide support for various discipline specific issues and assist in the completion of individual design tasks and calculations. Figure 2 shows how the *Building Composer* tools interact and how *Building Composer* and commercial-off-the-shelf (COTS) tools feed into the expanding facility model. These tools are described in more detail below.
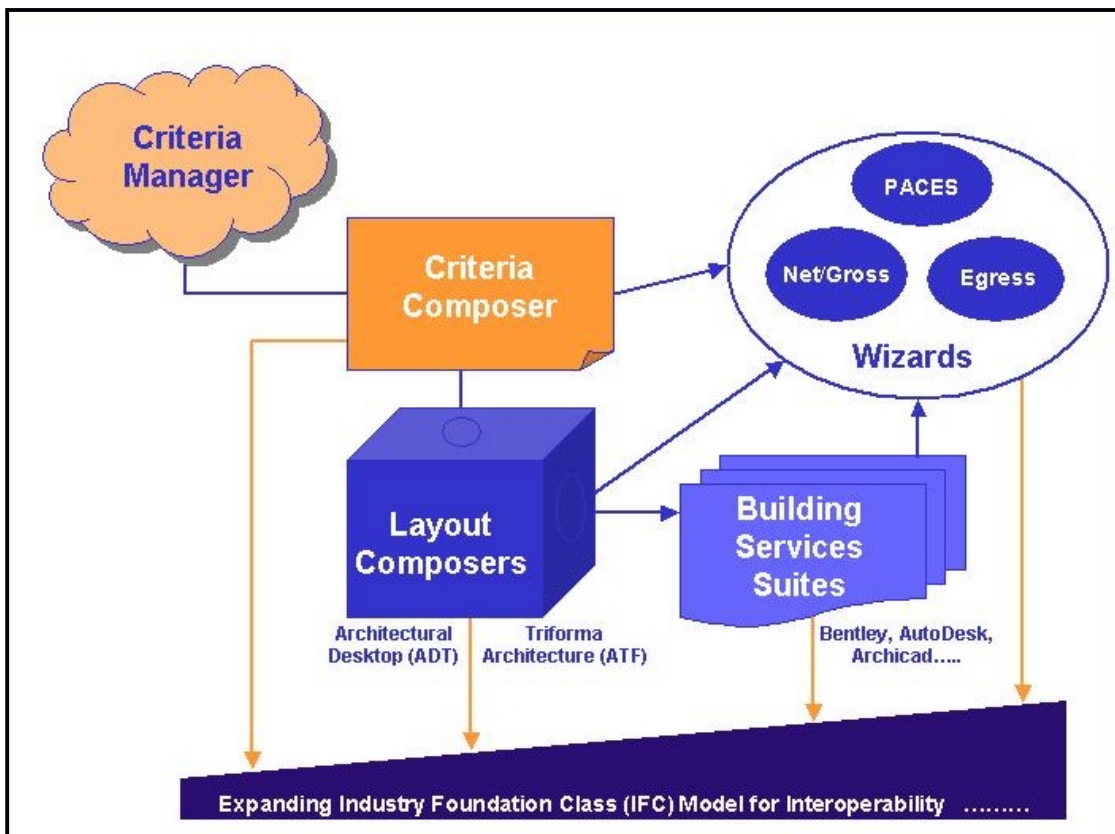

Figure 2. *Building Composer* Data Flow.

Criteria Manager

Building Composer relies on a customizable **customer-specific library** of architectural functions and criteria from which the architectural program is developed. Each customer will be able to create and customize these libraries using this web-enabled Criteria Manager application. Those authorized to use this tool can add new architectural functions, update their criteria, and notify interested parties. Criteria Manager will then export the criteria library in an XML-based format for use by the Criteria Composer.

Criteria Composer

Criteria Composer (Figure 3) is used to develop an architectural program and to add and set project specific criteria. This includes traditional information such as the total project

area and allocation of area to specific architectural functions such as circulation and offices. It also contains discipline-specific criteria such as requirements for structural, electrical, HVAC, lighting, and plumbing. The level of detail in the architectural program varies from project to project, and can be specified as such in the system.
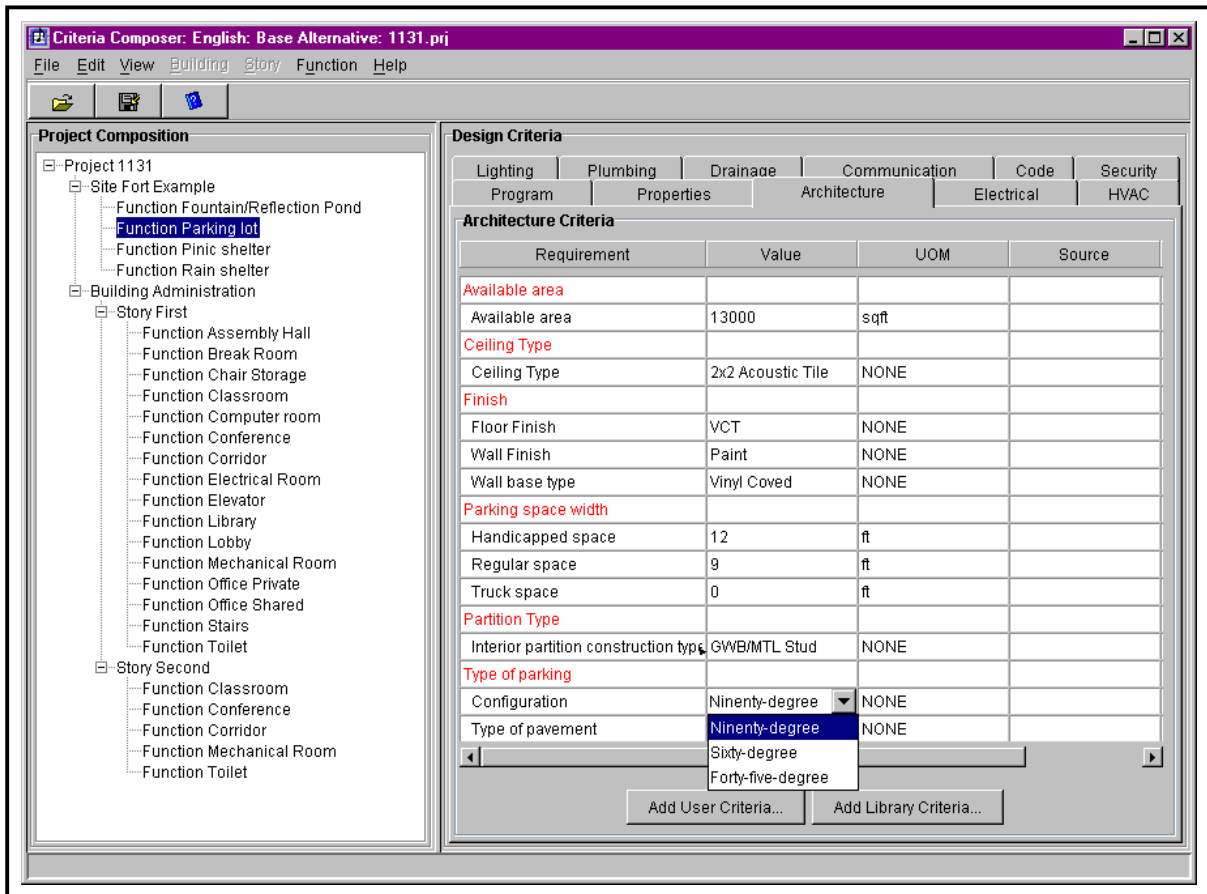

Figure 3. Criteria Composer.

With just a few parameters set, the information in Criteria Composer is sufficient to prepare a preliminary cost estimate and schedule. For example, it is acceptable to create a project that contains a list of architectural functions and their allocated areas without deciding how many buildings will be required. On the other hand, the planner may create a project with detailed information such as the number of buildings and the number of stories in each building. Obviously, the latter cost estimate will be more accurate. Typically, the planner will not create such a detailed program from scratch, but will copy it from a similar project and tailor it to suit the current customer's needs. Users benefit from Criteria Composer not only because it provides a method to capture, use, and reuse this explicit criteria, but also because it can often assist designers by

providing a deeper understanding of the rationale behind certain decisions, from which other, better, solutions could be considered.

Once the architectural program has been completed, *Building Composer* will support a programming level cost estimate with preliminary cost estimating tools such as the Parametric Construction Cost Estimating System (PACES™) via an XML-based exchange file. In addition, other applications that comply with the IAI or BLIS standard can also be used.
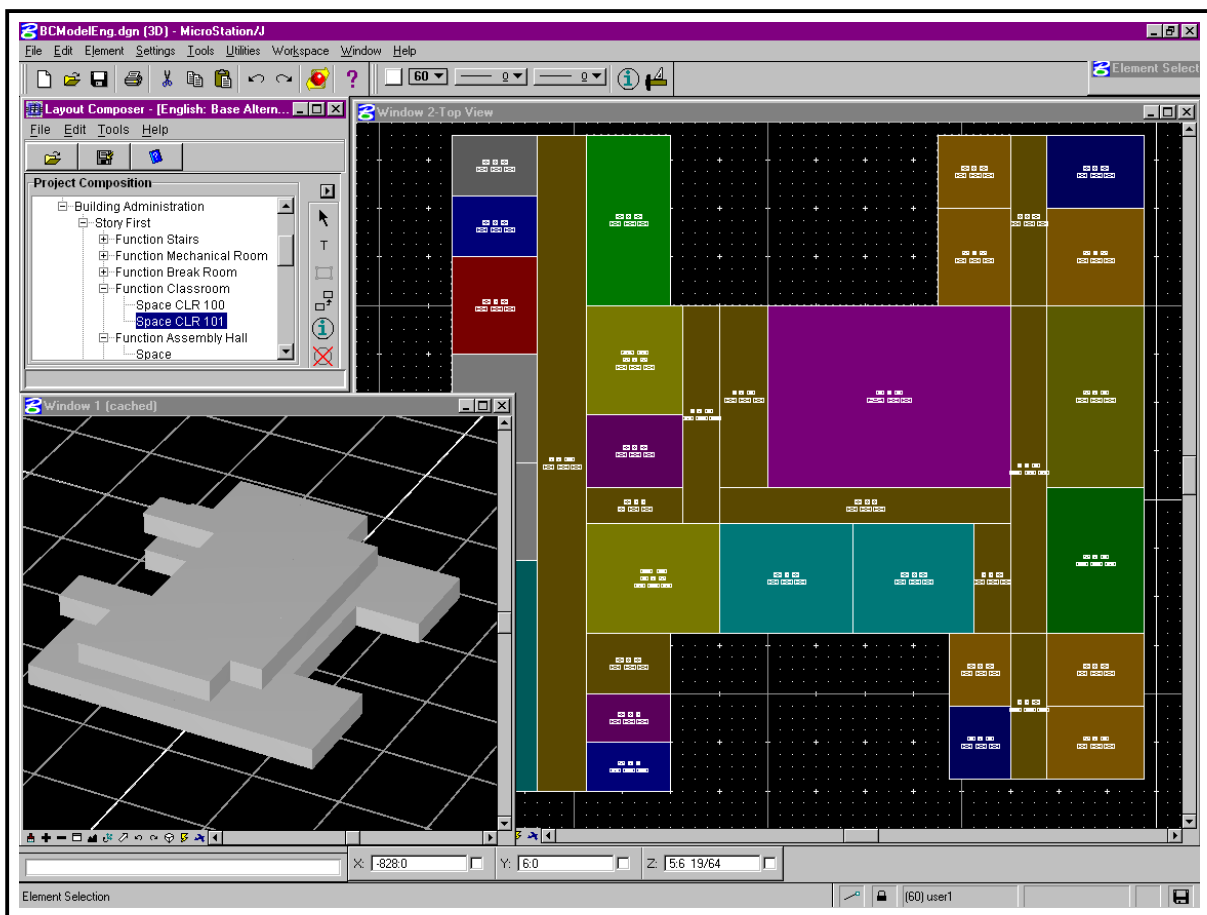

Figure 4. Layout Composer in Microstation/J.™

Layout Composer

Layout Composer (Figure 4) supports the creation of conceptual facility designs. Layout Composer works in conjunction with MicroStation TriForma™ or AutoCAD Architectural Desktop™ and uses the programmed area and criteria established in Criteria Composer as a point of reference and comparison during design. In this phase, the architect would then determine how many stories are needed and what functions would work on which stories (blocking and stacking). Given chosen requirements such as building footprint,

street appeal, adjacency, structure, building systems, form, and massing, the designer can explore conceptual alternatives to determine the best overall solution.

The spatial configurations that are created are not simply abstract geometry. The underlying model recognizes these spaces as offices, corridors, restrooms, or any other function in the customizable library, and therefore understands and provides reference to all of the criteria that applies for that particular function. For example, restrooms require an exhaust air system while offices do not. The default criteria associated with each space is sufficient to use Wizards to create a preliminary design and programming level cost estimate, along with other types of analysis. System selections can be made at this stage, but are not required.
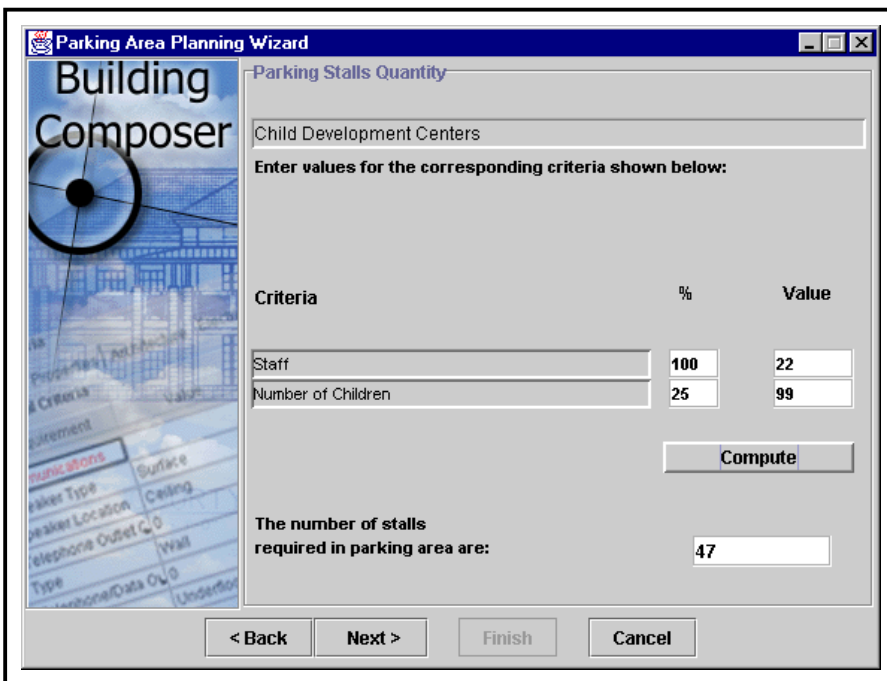
Layout Composer assists in the design process by providing an environment that explicitly (and parametrically) supports the concepts of multiple stories, functions, and spaces. This simplifies the interface by allowing operations to occur on these elements rather than requiring an understanding of the native CAD platform commands. For example, to change the floor-to-floor height of all of the spaces on a particular story, one just needs to change the value on the story and all of the spaces comply, rather than selecting walls and stretching them as in a typical CAD environment. Also, deleting a story is as simple as deleting the item in the tree hierarchy interface as is commonly done on files on today's operating systems, rather than requiring an understanding of file referencing to other story drawings.

Another important concept and feature in Layout Composer is the ability to present the design differently based on the user's task and objective. For example, during design, a view named "Above / Current / Below" could be used to quickly see the spaces on the current story with the regular symbology, and all of the spaces on the stories below with a grayed line, and the spaces on the story above with a dotted line, as is a current convention in practice. This allows a quick assessment of the relation of forms on particular stories to other stories in a building. Other representations include a "Bubble Diagramming" view, which is useful for presenting conceptual relationships, and a "Color by Function" view, which provides visual feedback on functional groupings.

In addition, Layout Composer assists the designer by supporting the use of pre-designed solutions of configurations of one or more spaces. For example, if a particular building type typically uses one of four bathroom layouts, these can be stored and reused preventing the need to "reinvent the wheel" in subsequent designs.

Once a design proceeds past the Conceptual Design phase to the Design Development phase where system and component selections are no longer optional, *Building Composer* continues to provide value in several ways:

- Engineers can use Criteria Composer to reference and target the requirements associated with their discipline.
- Wizards are available to expedite the system selection process as well as other design tasks.
- The completed architectural program can be exported to a detailed cost-estimating tool as well as customizable reports.

Figure 5. Example Wizard.

Wizards

Wizards are software components that operate on a discrete design task by taking criteria and user input in order to create or manipulate a building and criteria model rapidly, all according to generally recognized or organization specific practices. A Wizard extends *Building Composer* functionality and knows how to use the criteria data expressed in Criteria Composer to create or analyze something in a useful way. An example of a simple wizard might be one that determines the number of parking stalls required for a building with a particular building occupancy level, based on an individual organizations standard design criteria tables and algorithms (Figure 5).

Wizards assist the designer in ensuring that the design solution meets the design guide requirements, in ensuring that the customer's requirements are being satisfied, and in providing additional accuracy and speed over manual calculations. Wizards do not encode only one particular method and set of data, but rather provide flexibility for adapting to different design practices, commonly by building type. There are three different categories of Wizards that can help users in different ways:

1. **Criteria Wizards** are wizards that assist a user primarily in Criteria Composer by providing one or more worksheets consisting of questions and answers, selection options, and structured data entry (to name a few) from which an algorithm or calculation is performed to arrive at a value for a particular criteria. The parking allowance Wizard in the example above is a perfect example of a Criteria Wizard.

2. **Model Generation Wizards** are wizards that interact with commercial off the shelf software to generate model components and objects through parametric modeling formulas or manual specification. Examples of these would be a Duct Layout Wizard based on supply and exhaust airflow, a Lighting / Ceiling Grid Layout based on grid spacing, diffuser layouts, lighting algorithms and requirements (footcandle, lumens).

   Of particular interest are model generation wizards that take an initial space layout of a building and then automate the generation of a building model consisting of walls, floors, ceilings, and roof objects. The building model here is based on the criteria established for each of the associated elements. For example, a particular function may specify a particular wall type and a building may specify a particular exterior wall type, from which the appropriate elements would be generated. At this point, Architectural Desktop or Triforma will be used to facilitate detailed design and construction document generation.

3. **Analysis Wizards** interact with third-party COTS analysis tools in addition to custom analysis tools written within *Building Composer*. Examples of third-party tools might include: energy analysis, security analysis, and force protection analysis. Analysis Wizards currently being considered for *Building Composer* are net to gross area calculation and preliminary egress analysis.

In summary, *Building Composer* is a suite of facility design tools that integrate **client-specific criteria** with a life-cycle facility model and commercial tools. Designers benefit from having criteria at hand and from having an a la carte toolbox of design and analysis wizards that automate tedious tasks, freeing designers, to a degree, to concentrate on higher-level design and use issues. Clients benefit from a **centrally managed set of criteria** that is explicitly addressed in the design process, therefore **improving quality**, supporting design **flexibility**, and **reducing the time and cost** of facility acquisition.

References

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Heckel, Jeffrey S., Draft Technical Report (TR), *Building Composer: The Development of an Object Model for Facility Planning and Design Based on Customer Criteria* (U.S. Army Engineer Development Center [ERDC], Construction Engineering Research Laboratory [CERL], June 2001).

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